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STUDIES OF THE AMERICAN FLORA—I

BY

JULIAN A. STEYERMARK

ASSISTANT CURATOR OF THE HERBARIUM

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JULIAN A. STEYERMARK

MORTONIODENDRON, A NEW GENUS OF TILIACEAE

Mortoniodendron Standley & Steyermark, gen. nov. Tiliacearum.—Arbores magnae, pube stellata, ramulis alternis. Folia alterna, subcoriacea, penninervia, integra, subtus parce pube stellata conspersa. Flores cymoso-paniculati, paniculis terminalibus, ramulis minute et dense stellato-tomentellis. Sepala 5, valvata, crasso-subcoriacea, extus dense stellato-tomentosa, intus glabra. Petala valvata, sepalis paullo breviora. Stamina numerosa, omnia fertilia, inaequalia, fasciculata, in phalanges disposita, exterioribus brevissimis, petalis opposita. Antherae 2-loculares, longitrorsum dehiscentes, extrorsae, apice mucronatae. Filamenta brevia, basi libera. Ovarium e calyce liberum, superum, 5-loculare, dense stellato-tomentosum, longitrorsum rugosum, ovulis numerosis, placentis protrusis affixis. Fructus capsula globosa, 5-locularis, rugulosa, basi et apice late rotundata, valvis crassis. Semina in quoque loculo 2–3.

Type species, *Mortoniodendron anisophyllum* (Standley) Standley & Steyermark. Panama.

At the time of its description, it was considered improbable that this Panama tree was properly referable to the genus *Sloanea*. However, no further attention was given it until recently, when Professor Samuel J. Record called attention to the fact that its wood was not that of *Sloanea*. He, in fact, considers the wood referable to the Sterculiaceae, and quite similar to that of the genus *Guazuma*, with which, of course, the tree can not be considered to be closely related.

Mortoniodendron is dedicated to Mr. Conrad V. Morton of the United States National Herbarium, who also has made a preliminary study of the plant. It is a pleasure to be able to give recognition, slight although this may be, to the excellent work that he has done upon Mexican and Central American plants, particularly those of Costa Rica, and in such groups as *Viburnum* and Gesneriaceae.

Mortoniodendron anisophyllum (Standley) Standley & Steyermark, comb. nov. *Sloanea anisophylla* Standley, Field Mus. Bot. 4: 228. 1929.

The conclusion by the authors that this new genus is a member of the Tiliaceae was reached only after long and careful consideration. The combination of stellate pubescence with numerous stamens in definite clusters, with the latter character the first approach to cohesion of filaments to form a staminal tube, is characteristic of the Malvales as defined by Engler and Prantl. The reasons for assigning this genus to the Tiliaceae rather than to the Sterculiaceae, which family was at first suggested, are several. The stamens are all fertile, no staminodia being present as in most sterculiaceous genera. The condition of the stamens being opposite the petals, a situation duplicated by some members of the Sterculiaceae, such as *Theobroma* and allied genera, might be somewhat indicative of a relationship with the latter family were it not for the fact that in such sterculiaceous genera the stamens are either accompanied by staminodia or are few in number. In the Tiliaceae numerous stamens are prevalent and are all fertile, and their grouping into definite clusters or bundles is found in a number of genera, while in the genus *Mollia* of the Tiliaceae some of the stamen clusters may be opposite the petals as well as the sepals. The valvate sepals and petals found in *Mortoniodendron* are further characteristic of some members of the Tiliaceae, whereas in Sterculiaceae, although valvate sepals are the rule, no genus is known with valvate petals. Moreover, the larger flower buds with the thickened sepals covered by a grayish buff tomentum and the occurrence of the flowers in a terminal, cymose panicle are much more easily duplicated in a number of Tiliaceae, such as *Tilia, Mollia, Apeiba,* and *Sloanea,* than in most sterculiaceous genera.

Although *Mortoniodendron* thus shows affinity to the Sterculiaceae, its numerous stamens with no co-existing staminodia would indicate that this genus has not yet approached the degree of staminal cohesion and partial sterilization which characterizes most of the Sterculiaceae. The fact that the numerous fertile stamens occur in definite groups seems to indicate that *Mortoniodendron* has advanced a step toward the sterculiaceous condition, while the fact that its numerous stamens are all fertile establishes its connection with the Tiliaceae. Thus, in respect to its staminal characters, the genus may be said to be a connecting link between the Tiliaceae and the Sterculiaceae.

Explanation of Figure 26.—Photograph of type collection of *Mortoniodendron anisophyllum* (Standley) Standley & Steyermark, with a dissected portion of the flower drawn (×9) to show pistil,

HERBARIUM
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Mortoniodendron anisophyllum
(Standley) Standley & Steyerm.
PLANTS OF PANAMA
Expedition of 1911, under the Capt. Marshall Field Fund, in cooperation with School of Forestry of Yale University and New York Botanical Garden
352. Sloanea anisophylla Standl.
Tree 40-50 ft. by 18 in. with spreading drooping full crown and low buttresses
JAN. - MARCH. 1930
COLL. G. PROCTOR COOPER
REGION OF ALMIRANTE,
PROVINCE OF BOCAS DEL TOR

FIG. 26. Photograph of type collection of *Mortoniodendron anisophyllum* (Standley) Standley & Steyermark. Flower drawn to show pistil, stamen cluster opposite petal, and sepal, and a single stamen unattached.

stamen cluster opposite petal, and sepal, and a single stamen unattached.

Explanation of Figure 27.—Photograph of type collection of *Mortoniodendron anisophyllum* (Standley) Standley & Steyermark, showing the fruit.

NEW SOUTH AMERICAN EUPHORBIACEAE

In attempting to determine several South American Euphorbiaceae, a number of novelties have been encountered, of which the following represent a preliminary study.

Conceveiba magnifica Steyermark, sp. nov.—Arbor 25 m. alta; ramulis junioribus pilis minutis stellatis conspersis; petiolo 3–6.5 cm. longo, minute stellato-pubescente, apice obscure glandulari; limbis late ellipticis vel oblongo-ellipticis, 12–22 cm. longis, 7.5–12 cm. latis, apice obtusis, basi obtusis, leviter crenatis, membranaceis, supra viridibus, subtus pallidioribus et prominente reticulatis, costis 12–16, parce et minute stellato-pubescentibus; inflorescentia feminea 6.5–9 cm. longa, simplici, elongata, ramulo robusto, 2–3 mm. crasso, dense pubescente; floribus femineis in pedicellis crassis, glandulis basi magnis nigris 1.5 mm. longis, 1 mm. latis; sepalis femineis lanceolatis, acuminatis, 2.5 mm. longis, extus et basi intus dense tomentosis, basi eglandulosis; ovario ovoideo, dense tomentoso; columna stylari 1–2 mm. longa; ramulis stylaribus crassis, bilobatis, recurvato-patentibus, 3 mm. longis.—Brazil: State of Amazonas, Municipality São Paulo de Olivença, basin of Creek Belem, basin of Rio Solimoes, October 26–December 11, 1936, *Krukoff 8698* (type in New York Botanical Garden herbarium).

Differs from the other species in its very densely tomentose ovary, much larger and membranaceous leaves, and in the lack of glands at the base of the sepals.

Conceveiba Krukoffii Steyermark, sp. nov.—Arbor 15 m. alta, trunco 10 cm. diametro, saltem ramulis junioribus pilis minutis stellatis conspersis; petiolo 1.5–4.5 cm. longo, minute stellato-pubescente, apice indistincte glandulari; limbo oblongo-ovato vel late oblongo-elliptico, obtuse et abrupte caudato-acuminato, apice obtuso, distante et inconspicue dentato, coriaceo, reticulato, supra nitido, concolore, costis et superficie inferiore parce minute stellato-pubescentibus; inflorescentia mascula non visa; sepalis femineis 5 ovato-lanceolatis, acuminatis, 2–2.2 mm. longis, stellato-pubescentibus similiter ut pedicellis; glandulis basi calycis feminei et basi

HERBARIUM
FIELD MUSEUM
Mortoniodendron anisophyllum
(Standley) Standley & Steyermark
PLANTS OF PANAMA
Expedition of 1935, under the Capt. Marshall Field Fund, in cooperation with School of Forestry of Yale University and New York Botanical Garden
352. Sloanea anisophylla Standl.
Tree 40-50 ft. by 18 in. with spreading drooping full crown and low buttresses. Creamy white fls. and brown globular fr. are conspicuous. Fr. pendulous on long stalks, splits open on "seams" as it dries on tree
JAN. - MARCH, 1935
COLL. G. PROCTOR COOPER
REGION OF ALMIRANTE,
PROVINCE OF BOCAS DEL TORO

FIG. 27. Photograph of type collection of *Mortoniodendron anisophyllum* (Standley) Standley & Steyermark, showing fruit.

pedunculi nigris oblongis, 1.5–1.8 mm. longis, ca. 1.5 mm. latis; ovario ovoideo, obtuse trigono, tomentello; stylis inferne in columellas ca. 3 mm. longas connatis, ramulis stylaribus carnosis, bilobatis, recurvato-patentibus, 4–5 mm. longis; capsula (immatura) 1.5 cm. longa, 1.3 cm. lata, obtuse trigona, angulis carinatis, 1.3 cm. lata.—Brazil: State of Amazonas, Municipality São Paulo de Olivença, near Palmares, basin of Rio Solimoes, September 11–October 26, 1936, *Krukoff 8396* (type in New York Botanical Garden herbarium); same locality, on terra firma, high land, *Krukoff 8533* (N. Y. Bot. Gard. herb.).

This species differs from *C. guyanensis* principally in the longer style column, 3 mm. long.

Conceveiba simulata Steyermark, sp. nov.—Arbor 20–25 m. alta, trunco 17 cm. diametro, saltem ramulis et inflorescentiis firmiter et minute stellato-pubescentibus, ramulis vetustioribus mox glabris; petiolo 1–3 cm. longo, tenui, dense minute stellato-pubescente; limbo elliptico-oblongo vel oblongo, 7–12 cm. longo, 2.5–5 cm. lato, obscure et distante serrulato, apice caudato-acuminato, basi obtuso vel acutiusculo, supra laevi et nitido, subtus minute et parce stellato-pubescente, costis eminentibus et ad marginem adscendentibus, reticulato, concolore; inflorescentia mascula late pyramidali, stellato-pubescente; inflorescentia feminea non visa; calyce masculo 3–4-partito, lobis ovatis, acutis, glabris; staminibus exterioribus plerumque 9, interioribus sterilibus, plerumque 9–10, flexuosis, exteriores excedentibus, filamentis latis—Brazil: Terra firma, high forest, State of Amazonas, Municipality São Paulo de Olivença, basin of Creek Belem, basin of Rio Solimoes, October 26–December 11, 1936, *Krukoff 8616* (type in New York Botanical Garden herbarium); same locality and date, *Krukoff 8609* (N. Y. Bot. Gard. herb.).

This species is similar to *C. guyanensis*, from which it differs in its much shorter staminate inflorescence, and in possessing a greater number of fertile and sterile stamens, usually 9 fertile and 9–10 sterile.

Mabea Klugii Steyermark, sp. nov.—Arbor 6 m. alta; ramulis inferne glabris, superne furfuraceo-pubescentibus; petiolo 0.4–0.6 cm. longo, cano-furfuraceo, puberulento; foliis oblongo-lanceolatis, 7–14 cm. longis, 2–3.8 cm. latis, basi rotundatis, apice abrupte caudatis, coriaceis, supra laevibus nitidisque, subtus furfuraceis, costa media et basi limbi densius furfuraceis, minute cano-puberulentis vel fuscis, subtus pallidis et glaucescentibus, subintegris vel minute crenulato-

denticulatis, costis 15–20 paribus, divaricate patentibus; stipulis conspicuis, in ramulis florescentibus persistentibus, lineari-lanceolatis, setaceis, 1.7–1.9 cm. longis, furfuraceis; paniculis 1.8 dm. longis, in parte mascula 2.5 cm. latis, in parte feminea 3 cm. latis, axe dense furfuraceo-tomentoso; pedicellis masculis umbelliformibus, cinereo-puberulentis, 1.2–1.4 cm. longis, basi firmiter valde biglandulosis, glandulis nigris, oblongis, 2 mm. longis, 1 mm. latis; sepalis masculis apice rotundatis, firmiter cinereo-puberulentis; staminibus 25–30; antheris subsessilibus; bracteis stamina subtendentibus ovatis 4–5 mm. longis, acuminatis; sepalis femineis cum 3 sepalis exterioribus magnis 4.5–6 mm. longis, 3 sepalis interioribus leviter longioribus, 5.5–6.5 mm. longis, ovatis, valde acuminatis, intus dense glandularibus, extus firmiter cinereo-puberulentis, bracteis subtendentibus conspicuis, ovatis, acuminatis, 0.8–1 cm. longis, 3–4 mm. latis; columna stylari 0.8–1 cm. longa, ramulis liberis 6–7 mm. longis.—Colombia: Forest, Comisaria del Putumayo, Umbria, 0° 54′ N., 76° 10′ W., alt. 325 meters, January–February, 1931, *Klug 1969* (type in the Herbarium of Field Museum).

This is the second species of the section *Intermediae* to be known, both species of the section being thus far limited to Colombia. The only character common to both the members of this section (*M. Klugii* and *M. Trianae*) is the glandular inner surface of the pistillate sepals. *Mabea Klugii* is at once distinguished from *M. Trianae* by its much larger pistillate bracts and sepals, by the occurrence of glands at the base of the much longer staminate pedicels, and by the peculiar pubescence, especially on the lower surface of the leaves.

In general habit it combines characters found in several species of section *Umbelluliferae*. It is related in appearance to *M. Taquari* but differs from this species in the basal glands, the longer panicles, and longer pistillate bracts and sepals; it differs from *M. Piriri* in similar characters and in pubescence, and from *M. fistuligera* it differs in having a less ferruginous pubescence and an umbelluliform inflorescence.

Mabea Standleyi Steyermark, sp. nov.—Frutex 2 m. altus; ramulis glabris, olivaceo-fuscis; petiolo 0.8–1 cm. longo; foliis oblongis vel elliptico-oblongis, 12–20 cm. longis, 5.5–6.5 cm. latis, subintegris, apice abrupte caudatis, basi obtusis, omnino glabris, concoloribus, subtus fuscis, costis subtus conspicuis arcuato-ascendentibus cum 11–12 paribus 1–1.5 cm. distantibus, ante margines extendentibus cum arcis magnis conjungentibus; stipulis conspicuis in ramulis

florescentibus persistentibus, lineari-setaceis, 1–1.2 cm. longis; paniculis 11 cm. longis, 2.5 cm. latis, axe firmiter cinereo-puberulente, pedicellis masculis 1–1.3 cm. longis, firmiter cinereo-puberulentis, basi juxta axem valde biglandulosis, glandulis nigris, globosis, 2–2.3 mm. longis; sepalis masculis apice rotundatis, purpureo-puberulentis, late rotundatis; staminibus 60–65, breviter stipitatis; sepalis femineis 2.5–3.5 mm. longis, purpureo-puberulentis, ovatis, acuminatis, intus eglandulosis; columna stylari 1.8–2 cm. longa, cinereo-puberulenta; stylis recurvatis 6 mm. longis.—Peru: Dept. Loreto, Florida, forest, Río Putumayo, at mouth of Río Zubineta, alt. 200 meters, March–April, 1931, *Klug 2064* (type in Herbarium of Field Museum).

This new species adds another member to the section *Umbelluliferae*. The number of stamens (60–65) and narrowly oblong panicles relate *M. Standleyi* to *M. speciosa*, from which species and from all other species of this section it is distinguished by its suborbicular glands being directly next to the rachis at the very base of each staminate branch of the panicle.

Mabea elata Steyermark, sp. nov.—Arbor 10 m. alta, ramulis furfuraceo-fuscis; foliis oblongis, apice abrupte caudato-acuminatis, basi obtusis, 8.5–11.5 cm. longis, 2.5–4.5 cm. latis, subintegris, subcoriaceis, supra in costa media et prope apicem furfuraceo-puberulentis, in superficie inferiore tota pube fusco-cana puberulentis, subtus fuscis; costis 15–17 paribus, in superficie inferiore non prominentibus nec ante margines conspicue confluentibus; stipulis absentibus; paniculis 11.5–16 cm. longis, 4–5.5 cm. latis, axe firmiter pallido-fusco pubescente; pedicellis masculis in racemis umbelluliformibus, 1.5 cm. longis, 2–3 mm. supra basim biglandulosis, glandulis nigris, pube fusca conspersis, magnis, 3–4 mm. longis, 2 mm. latis, dense cinereo-puberulentis; pedicellis masculis conspicue bracteatis, bracteis ovatis, acuminatis, 4–5 mm. longis, 2.5 mm. latis; sepalis masculis apice rotundatis, cinereo-puberulentis; staminibus 50–60; sepalis femineis 4.5–6 mm. longis, interioribus longioribus quam exterioribus, acuminatis, ovatis, pallido-fusco-cinereo-puberulentis, infra nigris et intus dense cinereo-glandularibus; columna stylari 8 mm. longa, fusco-tomentosa; stylis 1.2 cm. longis.—Peru: Dept. Loreto, forest, between Balsapuerto and Moyobamba, alt. 600–1,200 meters, August–September, 1933, *Klug 3206* (type in Herbarium of Field Museum).

The glandular inner portion of the pistillate sepals allies this species to the section *Intermediae*, it being the first of this section from Peru. In appearance the plant simulates some species of

section *Umbelluliferae* having numerous stamens, i.e., *M. caudata*, *M. speciosa*, and *M. pulcherrima*.

Mabea Piririoides Steyermark, sp. nov.—Arbor 12 m. alta omnino glabra; petiolo 6–7 mm. longo; foliis oblongo-lanceolatis vel elliptico-lanceolatis, basi acutis, apice abrupte acuminatis, 4–5.5 cm. longis, 1–2 cm. latis, concoloribus, firme membranaceis vel subcoriaceis, glabris, obscure crenulato-serrulatis, costis 8–10 paribus divaricato-adscendentibus, subtus prominentibus; axe et pedunculis fere omnino glabris, fuscis; paniculis 5–6 cm. longis, 1.5–2 cm. latis, pedicellis masculis cano-tomentulosis, 2.5–5 mm. longis; glandulis supra basim minutis, subglobosis vel oblongis, fusco-nigris; staminibus 27–33; antheris oblongis, sessilibus; pedicellis femineis cano-tomentulosis; sepalis femineis 6, 2 mm. longis, ovatis, acutis, cano-tomentulosis, intus eglandulosis; columna stylari ca. 1 cm. longa, ramulis liberis 4–5 mm. longis.—Brazil: Terra firma, Campo de Boa Esperança, State of Maranhão, Maracassumé River region, October 24, 1932, *Krukoff 1983* (type in Herbarium of Field Museum).

This new species is a member of the section *Umbelluliferae*, and is most closely related to *M. Piriri*, although also related to *M. parvifolia* and *M. subserrulata*. In several respects it may be distinguished. The glands on the staminate pedicels are smaller and less conspicuous, and are brownish black, not as dark as in *M. Piriri* or *M. parvifolia*. In *M. parvifolia* the leaves are obtuse at the base, whereas in *M. Piririoides* they are acute. In the new species the leaves on the lower surface are not grayish blue as they are in both *M. parvifolia* and *M. Piriri*, nor are they finely reticulated as in *M. parvifolia*. The leaves of *M. Piririoides* are shorter, more coriaceous, and less serrulate than in *M. Piriri* and smaller than in *M. subserrulata*. Finally, the style column in *M. Piririoides* is longer than in *M. parvifolia*.

Richeria submembranacea Steyermark, sp. nov.—Arbor 17 m. alta, trunco 12 cm. diametro, ramulis glabris; petiolo 0.5–1.2 cm. longo, minute strigilloso vel glabro; foliis obovato-ellipticis, 7.5–11.5 cm. longis, 3.5–5.5 cm. latis, supra glabris et obscuris, subtus glabris, concoloribus, integris, basi acutis, apice abrupte caudatis, membranaceis vel submembranaceis, costis 6–8 paribus; inflorescentiis masculis tenuibus, 9–11 cm. longis, dense pallido-fusco-hirtellis; floribus masculis in pedunculis brevibus 1.5 mm. latis, sepalis 5, late ovatis, obtusis, extus paullo hirtellis; staminibus 5, antheris introrsis, glandulis 5 alternantibus; inflorescentia feminea

non visa.—Brazil: State of Amazonas, Municipality São Paulo de Olivença, near Palmares, basin of Rio Solimoes, September 11–October 26, 1936, *Krukoff 8513* (type in New York Botanical Garden herbarium).

This new species of *Richeria* differs from all the others in its submembranaceous leaves. From *R. grandis* it may be distinguished by its pedunculate staminate flowers, while from *R. laurifolia* it at once differs in its thin, entire, abruptly caudate leaves. The male flowers are smaller than in *R. obovata* and the inflorescence and leaves are shorter than in *R. racemosa*.

Drypetes amazonica Steyermark, sp. nov.—Frutex 6–11 m. altus; ramulis glabris cinereis; foliis subcoriaceis, ellipticis, basi acutis apice sensim acuminatis, integris, 12–24 cm. longis, 3–7 cm. latis, per omnes partes glabris, concoloribus; petiolo 0.4–1 cm. longo, glabro; floribus masculis 7–numerosis in axillis foliorum fasciculatis, pedicellis 3–4 mm. longis, tenuibus, sepalis 4, subrotundatis, extus sparse strigillosis, margine minute ciliatis, 2.6–2.9 mm. longis, 2.1–2.3 mm. latis; staminibus 8–10, discum centralem cingentibus; ovarii rudimento nullo; floribus femineis 1–3 in axillis foliorum, sepalis 5, rotundatis, 3–3.5 mm. longis, 2.2 mm. latis, extus pilosulis, rubris; fructu drupaceo, pyriforme, tomentoso, immaturo 1.5–1.7 cm. longo.—Brazil: Amazonas, on varzea land, basin of Rio Madeira, Municipality Humayta, near Tres Casas, September 14–October 11, 1934, *B. A. Krukoff 6210* (type in New York Botanical Garden herbarium; fragment in Herbarium of Field Museum); same locality and date, *Krukoff 6176* (New York Botanical Garden herbarium); same locality and date, *Krukoff 6196* (Herbarium of Field Museum); Amazonas, on terra firma, basin of Rio Madeira, Municipality Humayta, near Livramento, on Rio Livramento, October 12–November 6, 1934, *Krukoff 6630* (New York Botanical Garden herbarium); same locality and date, *Krukoff 6711, 6734* (New York Botanical Garden herbarium).

This new species of *Drypetes* belongs to the section *Hemicyclia* (Wight & Arn.) Pax & K. Hoffm. It is related to *D. variabilis* Uitt., from which it differs in the 7–many-flowered instead of 1–3-flowered staminate fascicles, in the number of stamens, which are 8–10, rather than 4–7, and in the greater leaf length and long-acuminate apex. It is also related to the West Indian *D. keyensis*, from which it differs in leaf shape and apex, much larger number of staminate-flowered fascicles with longer filaments, and 4 instead of 5 staminate

sepals, and to the West Indian *D. Picardae*, which has a different leaf shape and apex.

A NEW BRAZILIAN SPECIES OF MENDONCIA

Mendoncia Mello-Barretoana Steyermark, sp. nov.—Planta volubilis, caulibus teretibus, sulcatis, pilis patentibus flavidis hirsutis; foliis late ovatis vel elliptico-ovatis, apice abrupte cuspidato-acuminatis, basi rotundatis vel acutis, 7–11 cm. longis, 4–7.5 cm. latis, pagina superiore dense pubescentibus, pilis brevibus basi strumosa nascentibus, pagina inferiore dense molliterque flavido-pubescentibus; petiolo 1.7–3 cm. longo, dense pilis patentibus flavidis pubescente; bracteolis oblongo-ovatis, apice rotundatis mucronatis, mucrone fere 2 mm. longo, 2.5 cm. longis, 1.7–2 cm. latis, pilis brevibus patentibus flavidis pubescentibus, 0.5–0.8 mm. longis; pedicellis 4–5 cm. longis, dense pilis patentibus pubescentibus; calyce cupulare, 2.5–3 mm. longo, dense adpresso-pubescente; corolla infundibuliformi, extus glabra, fere 4.5 cm. longa, tubo fere 2.2 cm. longo, basi 0.6 cm. diametro, alba, fauce cum rubro lineato; ovario 5 mm. alto, dense flavido-hispidulo; stylo 2.3 cm. longo, inferne leviter puberulo, superne glabro.—Brazil: Suyo, Jardim Botanico, Municipio Bello Horizonte, Minas Geraes, December 1, 1934, *H. L. Mello Barreto 226* (type in Herbarium of Field Museum).

This new species of *Mendoncia* is characterized by its dense, short, spreading, yellowish brown pubescence on all parts, large, infundibuliform corolla 4.5 cm. long, whose throat is striped with reddish, and densely hispidulous, cupuliform calyx. This last character separates it at once from the related *M. albida*, *M. puberula*, and *M. hirsuta*. From the Peruvian *M. Killipii* it is distinguished by its much larger and differently colored corolla.

A NEW VIGUIERA FROM MEXICO

Viguiera Shrevei Steyermark, sp. nov.—Herbacea erecta, superne ramosa, caule valido per omnes partes praeter partes supremas fere glabro; foliis fere oppositis superne interdum alternis anguste lanceolatis acutis distante et obscure denticulatis sessilibus penninerviis, supra viridibus et minute tuberculato-hispidulis, infra pallidis et dense canescenti-hispidulis, 7–14 cm. longis, 0.8–2 cm. latis, membranaceis; pedunculis pluribus, nudis, monocephalis, cano-hirtellis, 8 cm. longis; capitulis majusculis, ca. 5 cm. latis luteis homochromis; disco 1.2 cm. alto, 1.7 cm. lato, involucro 2–3-seriato, bracteis exterioribus foliaceis discum excedentibus lanceolatis acutis 19–27 mm. longis, 3–5 mm.

latis, 1-nervatis, canescenti-hirtellis, herbaceis; radiis speciosis 15–18, oblongo-obovatis, apice rotundatis tridentatis 2–2.2 cm. longis, 10 cm. latis; pappo nullo; achaenio glabro.—Mexico: Chihuahua, stream bank near San Juanito, District of Bocoyna, alt. 2,400 meters, July 26, 1937, *Forrest Shreve 8035* (type in Herbarium of Field Museum).

It is a pleasure to dedicate this new species to Dr. Forrest Shreve, who has contributed such valuable studies on the flora of the southwestern United States and adjacent Mexico.

Viguiera Shrevei, with its herbaceous, 2–3-seriate involucre and epappose achene, is obviously a member of the section *Heliomeris* (Nutt.) Blake. It appears most closely related to *V. multiflora* (Nutt.) Blake, var. *genuina* Blake, from which it differs in its much stouter and mostly glabrous stems which are canescent only at the top and on the peduncles, larger leaves and heads, longer and broader rays, and conspicuously foliaceous involucral bracts.

ANOTHER NEW SPECIES OF SELENIA FROM TEXAS

Selenia oinosepala Steyermark, sp. nov.—Herba acaulis vel caulescens annua hiemans glabra; foliis pinnatim dissectis, divisuris primariis et secondariis pinnatifidis, segmentis ultimis oblongis vel obovatis apice obtusis; sepalis roseo-purpureis vel vinaceis, 8–9 mm. longis, oblongo-lanceolatis, caudatis; petalis luteis, 10–11 mm. longis; stylo 3 mm. longo; siliquis immaturis; seminibus orbicularibus alatis.—Texas: San Benito, February 28, 1930, *Eula Whitehouse* (type in herbarium of the University of Texas; fragment in Herb. Field Mus.); San Benito, February–April, 1931, *Mrs. Paul Cottrell* (herbarium of the University of Texas).

This new species is the sixth one of the genus to be described, the most recently published ones being *S. mexicana* Standley,[1] *S. Jonesii* Cory,[2] and *S. grandis* Martin[3] (see p. 443). From all species of the genus *S. oinosepala* differs in its remarkable rose- or pink-purplish sepals of delicate, petaloid texture. In habit, cut of foliage, caudate sepals, and length of style it resembles and is most closely related to *S. dissecta* Torr. & Gray. Besides the colored sepals, *S. oinosepala* differs from *S. dissecta* in its smaller petals, 10–11 mm. long instead of 13–15 mm. as in *S. dissecta*, and in its obtuse rather than

[1] P. C. Standley. Studies of American Plants. Field Mus. Bot. 17: 191. 1937.

[2] V. I. Cory. A New Selenia from the Edwards Plateau of Texas. Rhodora 33: 142. 1931.

[3] R. F. Martin. A New Selenia from Texas. Rhodora 40: 183. 1938.

acute or acutish ultimate leaf segments. From *S. mexicana* Standley and *S. Jonesii* Cory it differs in its entirely distinctive foliage and larger flowers.

Selenia oinosepala has been collected thus far only in the region of San Benito, Cameron County, in the extreme southeastern corner of Texas. This portion of the Gulf Coast has a number of other interesting isolated species, among which may be mentioned *Grindelia oolepis* Blake.

GROSS MORPHOLOGY OF THE GENUS GRINDELIA

This paper concludes the monographic treatment of the genus *Grindelia* which was started in 1931, and is a part of the series of "Studies in Grindelia I, II, and III" published respectively in volumes 21 and 24 of the *Annals of the Missouri Botanical Garden*. Monographic studies are now in progress on the genera *Chrysopsis*, *Gutierrezia*, and *Liatris*.

HABIT

The genus *Grindelia* comprises annuals, biennials, and perennials. Some of the Mexican and Texan species are annuals, whereas most, if not all, the Californian species are perennials. The perennial habit is particularly evident in the Pacific coastal species, many of which frequent salt marshes and tidal estuaries. Species, like *G. lanceolata* and *G. squarrosa*, may be both biennial and perennial.

Most of the biennials in *Grindelia* produce a many-leafed rosette the first season and flower the next. *Grindelia lanceolata* and *G. squarrosa* well illustrate two different types of biennials. *Grindelia lanceolata*, a late-flowering species, from July to early November, matures its seeds late in autumn, and during the ensuing winter the seeds fall to the ground. The following spring, germination normally occurs and the rosette of leaves which forms carries the plant over until the following spring when the second season's growth, with flowering stems, occurs. This species is normally a biennial, dying at the close of the second season. Sometimes, however, a basal rosette of leaves remains attached to the stem, endures the winter, and the plant flowers a third or fourth season or sometimes longer, as sometimes occurs when plants growing along railroad tracks are cut close to the ground and the roots are thereby stimulated to perennate. The same process of cutting the flowering stems close to the ground will stimulate *G. squarrosa* to act as a perennial. This last species, usually a biennial, blooms earlier than *G. lanceolata*, commonly June–August, ripens its seeds in late summer, and germina-

tion mostly takes place the same season, in early or late autumn. These seedling plants produce a few leaves which tide the plant over the winter, and the following spring and summer more rosette leaves are produced, which endure the succeeding winter. Then, the next year the first flowering stems are produced.

ROOTS

The root system in all cases is that of a tap root rarely extending more than 6 decimeters below the surface of the ground. The perennial and often some biennial species develop a semi-ligneous root, which becomes more and more lignescent with age. The tap root is usually vertical, but sometimes develops curvatures when the plant occurs in rocky or gravelly soil or on steep hillsides or in other habitats where obstructing masses may prevent a normal vertical growth.

STEMS

The plants are all caulescent, but the stems may vary from such dwarf types as *G. microcephala* var. *pusilla* and *G. squarrosa* f. *depressa*, only a few centimeters tall, to very tall plants, like *G. camporum* and *G. procera*, the latter commonly reaching a height of 2–3 meters. In the majority of the species the stems are herbaceous, arising directly from the crown at the surface, or the crown may produce short, simple or branched basal caudices which remain above ground, become semi-ligneous in age, and in turn give rise to herbaceous stems of the season. These herbaceous stems die down at the close of each growing season. A number of species, such as *G. humilis*, *G. Blakei*, *G. arenicola* and *G. stricta* var. *Hendersoni*, but only those inhabiting salt marshes, tidal estuaries, coastal and sand dunes or beaches, and similar habitats, are suffrutescent or even suffruticose. In *G. arenicola* and *G. stricta* var. *Hendersoni* the basal portion of the stem is ligneous, the ligneous portion is comparatively slender and attains at most a length of 2–3 decimeters, whereas in *G. humilis*, especially in older plants, the ligneous portions may be very conspicuous and occupy over half the length of the entire plant, the woody cylinder attaining a length up to a meter or so and a surprising thickness of 6 centimeters. These aerial ligneous stems are perennial and remain above ground throughout the duration of the life of the plant, giving rise each season usually from the upper portions to herbaceous or semi-herbaceous stems of the growing season. This development of persistent, aerial, suffruticose stems in these littoral species seems to be directly correlated with the environmental conditions of such habitats.

The stems are simple and monocephalous in the South American *G. globularifolia* and *G. chiloensis*, and in the Mexican *G. inuloides* var. *glandulosa*. The other North American species are practically always branched, the heads being arranged on mostly corymbosely to paniculately branched, floriferous branchlets. The stems are mostly terete and without prominent striations or grooves. In *G. stricta* the stems may be slightly flattened and oval or elliptic in cross section. Some species, like *G. integrifolia* and *G. Howellii*, have deeply grooved or furrowed stems, especially in the upper portions. The stems may be entirely glabrous or strongly villous or sublanuginose. The hairs are multicellular and often slender, weak, and crooked. Often the pubescence, when present, is confined toward the heads, as in *G. stricta*, or various species may be pubescent throughout in the early stages of growth and in age become glabrous below. In the case of species which develop pubescence on the stems, a short, glandular, multicellular puberulence often occurs, especially near the heads. In addition to the glandular hairs being mixed with the non-glandular hairs, the stems of certain species, like *G. inuloides* var. *glandulosa*, may become almost predominantly glandular.

Erect or ascending stems are the general rule in the genus. In *G. stricta* var. *procumbens* the stems are procumbent, widely and almost horizontally spreading. *Grindelia arenicola* and var. *pachyphylla* often develop procumbent stems from the suffrutescent basal axes.

LEAVES

The leaves in the same species are tremendously variable in outline and margin but at the same time very characteristic, and often serve as taxonomic criteria, at least in part, in the matter of the differentiation of the various entities. The radical and lower cauline leaves may be conspicuously pinnatifid, lyrate, laciniate, or incised-dentate. As the middle cauline leaves are approached, the pinnatifid or laciniate condition becomes less marked, the divisions become reduced and more crowded, and with the gradual reduction in size of the upper cauline leaves and those on the floriferous branchlets the margin becomes more regularly serrate, dentate, or crenulate. Such a series of changes is to be noted in *G. squarrosa* var. *nuda*, *G. grandiflora*, *G. texana*, and *G. microcephala* var. *adenodonta*.

In some of the South American species, like *G. chiloensis* and *G. globularifolia*, the stems are more leafy near the base, whereas in most of the North American species this condition does not exist,

the leaves being more or less scattered on the stem from base to apex; only in some Mexican species, like *G. inuloides* and *G. inuloides* var. *glandulosa*, which often have very reduced leaves in the upper portion of the stem, is there any suggestion of a condition such as exists in the South American species mentioned.

The leaves are always alternate, and all, except the basal and lowermost cauline, which are mostly petiolate, are sessile. The main cauline leaves may be conspicuously narrowed below the middle to the base, as in *G. nana*, *G. subalpina*, and *G. stricta*, or they may be strongly ampliated and amplexicaul or subcordate as in *G. rubricaulis* var. *latifolia* and *G. rubricaulis* var. *robusta*. The middle and upper cauline leaves of many of the species are amplexicaul or subamplexicaul.

The shape of the leaves varies considerably even on the same plant. The basal and lowermost are usually attenuate into a petiole-like base, making the leaf spatulate to obovate. As the middle and upper cauline leaves are approached, the basal portion tends to become broader and less attenuated, and when the uppermost cauline leaves and those on the floriferous branchlets are reached, the basal portion in the majority of the species has come to be as broad or much broader than the breadth about the middle or apex. Such transitional changes in general shape and outline of the leaves require comparison of leaves from approximately the same areas on the main stem or branchlets if differentiation is to be made.

The texture of the leaves is exceedingly characteristic of many species. Most of the species have firmly membranaceous to subcoriaceous leaves, but there is much diversity. *Grindelia integrifolia* has membranaceous leaves, quite thin for the genus. Many of the coastal species show interesting correlations between leaf texture and environment. For example, *G. Blakei* and *G. humilis* and varieties of salt marshes and tidal estuaries develop leaves of very thick, coriaceous or leathery-fleshy texture, whereas *G. stricta*, *G. stricta* var. *procumbens*, and *G. stricta* var. *macrophylla* of tidal estuaries, salt marshes, or sandy beaches along the seashore have soft, fleshy leaves which are quite thin when dried and pressed. *Grindelia arenicola* var. *pachyphylla* of coastal sand dunes also develops thick, coriaceous or leathery-fleshy leaves.

The color of the leaves is a remarkably constant and definite taxonomic-genetic character for the different species. The dull or pale grayish or bluish green shades definitely mark such species as *G. perennis*, *G. squarrosa*, *G. squarrosa* var. *nuda* and var. *serrulata*,

pale yellow and light grass-green stamp *G. integrifolia, G. lanceolata, G. nana, G. arizonica,* and *G. texana,* whereas various types of dark greens characterize *G. humilis, G. Blakei,* and *G. rubricaulis* var. *robusta.*

Also of distinct taxonomic significance are the relative abundance and conspicuousness of resinous secretion in the leaves. In *G. camporum, G. squarrosa,* and its var. *nuda* the leaves are conspicuously punctate with resin-secreting areas, and the abundant resinous secretion frequently gives the surface a lustrous or almost varnished appearance. In other species, namely *G. hirsutula* var. *brevisquama, G. stricta* var. *macrophylla, G. lanceolata, G. inuloides, G. Greenmanii,* and *G. oolepis* the resinous secretion is so slight or negligible and the punctate areas so inconspicuous that the leaf does not appear at all resinous-punctate. Some species, like *G. squarrosa* and its var. *nuda* and *G. microcephala* var. *adenodonta,* have the closely and finely pectinate-serrulate or denticulate margins conspicuously resiniferous at the apex of the teeth, whereas many of the species lack resiniferous-tipped teeth.

ARRANGEMENT OF HEADS

The real inflorescence, as in all Compositae, is a capitulate one with a centripetal plan. In defining the type of inflorescence treated, the writer has regarded a single head as if it were a single flower. The mode of branching in the genus is always centrifugal or determinate, with the central head, which terminates the first developed axis, being the first to flower. The heads are sometimes disposed terminally on simple, unbranched stems, as in *G. globulariifolia, G. chiloensis,* and *G. inuloides* var. *glandulosa,* but more often are arranged on few- to many-branched stems. The mode of branching (not as to flowering) is most often corymbose or subcorymbose, typically exemplified by *G. squarrosa* and *G. lanceolata.* By elongation and irregularity in branching of the lateral axes a paniculate or subpaniculate type of branching may develop, as in *G. inornata, G. procera, G. humilis,* and *G. fastigiata.* When the lateral axes become more approximate and closely ascending they may produce a fastigiate appearance, as in *G. arizonica* var. *stenophylla, G. nana* and var. *turbinella,* and *G. fastigiata.* In *G. aggregata* the heads are agglomerated into a compactly arranged cluster, terminating simple, short, subracemosely or subcorymbosely branched floriferous branchlets.

HEADS

The heads are always homochromous and yellow; both radiate and discoid heads occur. Among the South American species only one discoid species, *G. discoidea*, is known. In Mexico *G. oxylepis* var. *eligulata* is discoid, whereas in the rest of North America discoid examples are met in *G. columbiana*, *G. rubricaulis* var. *bracteosa*, *G. oolepis*, *G. aphanactis*, *G. fastigiata*, *G. inornata*, and *G. squarrosa* var. *nuda*. Those species of *Grindelia* possessing radiate heads are by far in the majority.

When the heads are discoid all the flowers are tubular, actinomorphic, and perfect. When the heads are radiate and heterogamous, all the tubular disk florets are perfect, and the radiate florets are ligulate and pistillate.

The heads in all the species contain numerous florets, and a direct correlation exists between the size of the head and the number of its florets; such species as *G. oolepis*, *G. decumbens*, *G. laciniata*, *G. oxylepis* f. *capitellata*, *G. nana* var. *integerrima*, *G. tenella*, and *G. Robinsonii* with comparatively small heads possess far fewer florets than such large-headed species as *G. rubricaulis* var. *robusta*, *G. lanceolata*, *G. subalpina* var. *erecta*, *G. Blakei*, and *G. camporum*. While the heads of a given species average a more or less constant number of florets per head, yet the use of such a character has not been found of significance in the taxonomy of the group.

DISK

The shape of the disk is a definite character to be relied upon in *Grindelia*. The genus as a whole is typified by a subhemispheric or campanulate-hemispheric type of disk. In a number of species like *G. squarrosa*, *G. camporum*, and *G. rubricaulis* var. *robusta* the disk is depressed-hemispherical, in *G. arizonica*, *G. Hallii*, *G. decumbens*, and others it is campanulate or campanulate-hemispherical, and in well developed heads of *G. fastigiata* and *G. nana* var. *turbinella* it becomes deeply campanulate.

INVOLUCRE

After many attempts toward a natural classification of the genus, working with different criteria, the author has had to rely upon the characters of the involucre as a basis for major or minor divisions. As a criterion of definite taxonomic value the involucre serves not only as a convenient and readily usable character but also as an extremely natural one; moreover, the involucral characters in *Grin-*

delia are as fundamental as those of the pappus and achene. The involucre is always more or less graduated; sometimes the outermost bracts subtending the heads become so foliaceous as to obliterate the graduated appearance, as in *G. hirsutula* f. *patens*. The involucre is mostly 4–6-, sometimes 7–8-seriate.

Perhaps as a result of an evolutionary adaptation to environmental conditions, the resinous character of the involucre has become definitely tied up in the genetic constitution of the various species. Species of *Grindelia* growing in arid, dry, wind-swept habitats, where paucity of rainfall exists and where evaporation is great, as on prairies, plains, dry places along streams, semi-desert areas, and the like, often develop large quantities of resinous substances on the involucre. Examples of this type of correlation are found in *G. nana*, *G. squarrosa*, *G. fastigiata*, and *G. perennis*. On the other hand, species growing under conditions of more abundant rainfall or where the habitat is otherwise associated with more moisture often show much less quantities of resinous exudate, as in *G. integrifolia*, *G. stricta* and var. *macrophylla*, and others. The amount of resin present differs according to the species. It is very conspicuous and abundantly secreted in *G. nana*, *G. squarrosa*, *G. camporum*, *G. Blakei*, and *G. fastigiata*, whereas in *G. oolepis*, *G. Greenmanii*, *G. Palmeri*, *G. hirsutula* var. *brevisquama*, *G. scabra* var. *neomexicana*, *G. stricta* var. *macrophylla*, and others it is so scarce as to appear almost lacking; in many of these cases only the innermost bracts or the youngest heads produce any obvious resin secretion.

Many of the species, preceding and during the first stages of anthesis, exude a large amount of resinous substance which accumulates in excess at the summit of the head in the form of a white or cream-colored, sticky, viscous mass. This sticky mass diminishes in extent more or less in proportion as the centripetal evolution in anthesis progresses, some of it probably evaporating. This phenomenon is well observed in such resinous species as *G. squarrosa*, *G. subalpina*, *G. nana*, *G. camporum*, and many others.

The position of the involucral bracts is a very definite and useful character in distinguishing the various species. Whether the upper portions of the bracts are erect-appressed, ascending, spreading, reflexed-squarrose, or revolute is of fundamental taxonomic importance, but it is a character which must be used and studied carefully, and due allowance must be given for slight variations or for abnormally developed involucres. Interpretation of the position of the bracts on herbarium material may sometimes lead to confusion,

particularly when one is not experienced with the group. For example, a species which has the upper portions of the bracts revolute or strongly recurved or reflexed-squarrose may, when pressed and dried, have those bracts in the plant press straightened or curved out of the normal position. On the other hand, the upper portions of bracts which in nature are ascending or spreading, with straight tips may, upon being placed in the plant press, appear to be squarrose or abruptly bent back. If in such cases one will examine those portions of the involucre and bracts which have been least disturbed, such as near the base of the involucre or the sides, which have not had direct pressure applied to them, one usually will be able to decide what is the normal position of the bracts.

For the sake of clarity, the author desires at this point to explain the terms used in the keys and descriptions of the monograph for the various positions of the involucral bracts. Assuming that the original position of the upper portion of a bract were erect-appressed, it would pass through the following changes in the natural sequence of turning down, namely: erect-appressed, erect-ascending, ascending, spreading, horizontally spreading with straight tips, simply squarrose, slightly reflexed-squarrose, moderately reflexed-squarrose, strongly reflexed-squarrose, or recurved, then loosely and finally strongly revolute. Theoretically, all these terms denote definite positions; practically, only a few of them have been maintained.

Erect, ascending, and spreading are clear enough, but the stages between squarrose and revolute types grade into one another, and are sometimes difficult to construe. The bracts are squarrose only when the upper portions are projecting or spreading horizontally outward with the tips slightly sloping gradually downward or when slightly descending; in other words the bracts describe a more or less low-convex arc. As the tips of the bracts become more abruptly bent downward they pass into the reflexed-squarrose condition. At times, as often in *G. camporum*, the flexure at the tip is so abrupt downward in respect to the horizontally spreading portion as to give almost a geniculate or deflexed condition. For the sake of clarity and because the deflexed condition is often inseparable from a moderately or strongly reflexed one, only the term reflexed-squarrose is here used. The reflexed-squarrose condition may be only slightly marked or may become strongly bent downward. From this position, by the tip becoming more and more turned downward and then inward and upward, a recurved condition arises.

When the tip becomes farther curved upward it assumes a revolute appearance. A loosely or openly revolute bract is one in which the curvature described is rather gradual, and in which the revolute part of the bract shows obvious spatial separation between proximate portions. This condition is well exemplified by *G. Blakei*. A closely revolute condition is here used to express a further degree of revoluteness, in which the curvature described is more abrupt, and in which the revolute part of the bract is more tightly fitted within the curvature, giving a crowded, compact appearance to the figure. This is well observed in *G. revoluta* and *G. nana* and var. *integerrima*. The upper portion of the involucral bract may be involute, the tip becoming upwardly and inwardly recurved. This condition is best seen in *G. grandiflora*.

The upper portion of the involucral bract then is quite characteristic and for the most part constant. All the Mexican and South American species have either erect, ascending, spreading, or slightly reflexed-squarrose tips (the outermost may be slightly recurved at tip), but they are never revolute nor conspicuously recurved as in many North American ones.

In *G. oolepis*, *G. arizonica*, and *G. hirsutula* var. *brevisquama* the bracts as a rule are broadly lanceolate or ovate-lanceolate with short, acute to slightly acuminate tips. In most of the species the apex becomes more or less elongated, often slenderly filiform-subulate. The latter condition is very accentuated in *G. integrifolia*, *G. stricta* var. *macrophylla*, and *G. lanceolata*. In the last two species the free portion of the tip may be as long as 10–12 mm. and the outer and middle bracts may be free for one-half to three-fourths their total length, whereas in species like *G. humilis*, *G. arizonica*, *G. nana* var. *integerrima*, and others, in which the uppermost portion only is loose, the erect-ascending or revolute portion may be free only one-fifth or less the total length. There are all gradations between these extremes.

The texture of the bracts is mostly correlated with that of the leaves. Thin, membranaceous-leafed species, like *G. integrifolia*, possess similar types of bracts, whereas species possessing subcoriaceous or coriaceous leaves, like *G. squarrosa* and *G. arenicola* var. *pachyphylla*, show a similar development in texture in the involucral bracts. The tips of the involucral bracts may be conspicuously thickened and terete, as in *G. squarrosa*, *G. perennis*, *G. fastigiata*, *G. nana*, and *G. revoluta*, or may be only scarcely or not at all thickened and mostly flattened, as in *G. stricta* var. *macrophylla*, *G. inte-*

grifolia, and *G. hirsutula* var. *brevisquama*. In most of the species the upper portions of at least the inner and often the middle and outer bracts are resinous-punctate, either conspicuously and abundantly to slightly or less marked. In some of the thin, membranaceous, flattened, and scarcely or not at all thickened types the resinous-punctate areas are almost negligible.

In most of the species the involucral bracts are entirely glabrous. A short, villosulous or hirsutulous type of pubescence is found on the bracts in *G. hirsutula* and var. *brevisquama* and f. *tomentulosa*, *G. rubricaulis*, *G. stricta* var. *Hendersoni*, and var. *lanata*. Sometimes a short, glandular puberulence occurs on the outer or middle bracts, as in *G. inuloides* var. *glandulosa*.

In some species, like *G. arizonica*, the tips of the outer and middle bracts are conspicuously greener than the lower portions, whereas in *G. scabra*, *G. stricta*, *G. lanceolata*, and many others the bracts are uniformly green throughout.

RECEPTACLE

The receptacle of *Grindelia* is mostly flat or very slightly convex. In some species, such as *G. squarrosa*, the sides distend conspicuously downward in fruit, but most of the species do not exhibit this property. The receptacle goes through a definite sequence of development from the period of anthesis to that of fructification. The author has been able to observe from field study the series of changes which take place in *G. squarrosa* and *G. lanceolata*.

At least in *G. squarrosa* and *G. lanceolata* the obvious changes are as follows: the centripetal sequence of anthesis, beginning with the ray florets, then the outer disk florets, and subsequently more and more centripetally, allows the outer portion of the head to flower earlier and to be pollinated sooner than the inner and central part, and just as soon as the first ray and outer disk florets have come into anthesis, various dipterous, hymenopterous, and coleopterous insects ensure pollination and resulting fertilization. Consequently, these outer florets begin the process of ripening the seed even before the central and inner ones have even reached anthesis. The centripetal development of the florets in *G. squarrosa* goes on at a faster rate, with consequently a shorter period of anthesis for the entire head, than the corresponding development of the florets in *G. lanceolata*.

During the centripetal evolution of the florets in each species the receptacle increases in size. The outer margins of the receptacle

grow and gradually extend upward. During these changes the involucral bracts increase in size and elongate somewhat. Gradually the involucral bracts, especially the inner ones, together with the vigorous upwardly growing margin of the receptacle bend upward and inward centripetally. The inner bracts extend more and more centripetally and begin to close over the center of the head. Many of the central disk florets have not reached anthesis at this time or, if they have reached it, have been in that stage only a relatively short time.

Finally, the head becomes practically closed above by the growth inwardly of the receptacle and inner involucral bracts. At this stage the shape of the disk has become changed from its original appearance at the beginning of anthesis; it has now taken on a broadly conical or turbinate shape, the sides at the middle or base distending conspicuously outward and narrowed conspicuously at the top. When the head is examined at this stage the innermost disk florets frequently are found not to have been pollinated nor even to have reached anthesis. The heads remain closed over in this condition during the ripening and maturing of the seeds.

After a considerable lapse of time, as much as two or three months, the inner involucral bracts and the receptacle begin to show signs of losing their turgidity and original position; the inner bracts begin to bend upward and gradually outward while the margins of the receptacle are going through similar outwardly directed movements. Gradually the central and outer portion of the head again become exposed. In time the entire head is open and, except for its obvious increase in size, takes on the appearance which it possessed at the beginning of anthesis.

The opening of the head occurs only after the seeds are fully ripe. We see that the most striking phenomenon has taken place, namely the ray and outer disk florets have ripened seed, but practically all the numerous central and innermost disk florets (always hermaphroditic) have failed to ripen. This fact the author believes to be explained as follows: the ray and outer disk florets, being the first in the head to be in anthesis, require sufficient nourishment to ripen their seeds. The more central disk florets are placed at a disadvantage in flowering much later, for by the time they have gone into anthesis and have been pollinated the outermost ones have already begun to ripen seed and have monopolized the food supply, with the result that the central disk florets are gradually starved at the expense of the outer ones.

Also correlated with the lack of formation of seed in the central disk florets is the fact that the head becomes closed over by the involucral bracts before the central disk florets have gone into anthesis, or when they have been in anthesis only a short time. While these observations were made in the field only on *G. lanceolata* and *G. squarrosa*, the author has observed among the thousands of herbarium specimens that most, if not all, of the other species in the genus show heads which have produced ripe seeds on the ray and outer disk florets, whereas the central and innermost disk florets have failed to ripen seed.

The receptacle in most of the species is deeply foveolate. In *G. oolepis* there is scarcely any indication of a foveolate receptacle. The nature of this foveolation is worthy of note. Each foveola is bounded more or less on four sides by fleshy processes, which in anthesis surround the entire ovary, and in fructification subtend the base or lower part of the achene. These fleshy processes are often thick and turgid during anthesis as in *G. lanceolata*. Moreover, the foveolae occur in rows spirally arranged in clockwise fashion, each floret being subtended by a foveola, and consequently also arranged spirally in rows. Moreover, the fleshy processes protruding upward from the four sides of a foveola may become remarkably elongated, and attenuated to a sharply acute or acuminate apex. In this latter condition they appear very much as if they were reduced or degenerate paleae.

COROLLA

The disk florets, as has been stated previously, are always tubular and perfect, and the ray florets when present are always ligulate and fertile. The corollas are always glabrous.

RAY FLORET

The number of ray florets varies in each species, but for each species averages a more or less constant number. For example, in *G. tenella* the number of ray florets is ordinarily 15–18, whereas in *G. maritima* and *G. squarrosa* it is usually 25–35. The ligule generally is quite conspicuous and usually oblong or elliptic-oblong, or it may be narrowly linear-oblong to broadly oblong-spatulate. It varies from 5–7 mm. long in *G. Robinsonii* to 17–22 mm. long in *G. Nelsonii*, and in *G. Blakei* up to 25 mm. long. It is quite slender, only 1.5–2.5 mm. broad, with usually revolute margins, as in *G. squarrosa*, or relatively broad, 4–5 mm., with non-revolute margins, as in *G. stricta* var. *macrophylla*. Moreover, the ligule is obtuse or acutish,

obscurely 3-lobed or practically subentire at the apex and narrowed below into a slender, straight tube 3.5–7 mm. long. The color of the ligule is usually quite characteristic for the different species. Some species, *G. squarrosa* and *G. nana*, are pale or lemon-yellow-colored. Others, like *G. perennis*, *G. humilis*, *G. stricta* and varieties, are bright to orange-yellow, while *G. grandiflora* possesses orange-colored ligules. Those species inhabiting salt marshes, estuaries, and found in general near the coast develop a deeper, brighter orange-yellow than the ones inland. This deeper pigmentation may be associated with a higher salt content of the soil resulting in a denser protoplasm associated with higher osmotic pressure, or there may be some relation between the deeper pigmentation and the ability to absorb certain light rays which occur in coastal habitats.

DISK FLORET

The disk corollas are always some shade of yellow. They all are tubular, slender, and gradually or abruptly constricted about halfway down into a slender, straight tube. The lobes of the 5-toothed limb are short, 0.5–1.2 mm. long, lanceolate, oblong to ovate-lanceolate, acute or acutish. The veins are sometimes more prominent in certain species than in others, where, for example, as in *G. grandiflora* the veins are rather conspicuously brownish contrasted with the yellow color on the other parts.

The corolla is always 5-nerved and presents the usual condition found in the Compositae. Miss Koch,[1] in her anatomical studies concerning the composite flower, showed that the floral anatomy of the floret in *Grindelia* is very similar to that found typically in the Heliantheae, and not at all like those studied in the Astereae.

The disk corolla is too homogeneous and stereotyped in plan to offer any practical service in the differentiation of species or varieties, although the author has attempted many times to find characters which might be of use to segregate his entities as Wiegand did for the allies of *Aster lateriflorus* and *A. paniculatus*.

ANDROECIUM

The androecium of *Grindelia* is yellowish throughout and consists of five connate anthers with more or less elongate-oblong, oblong-lanceolate, or ovate, acutish or obtuse, terminal appendages and short, broadly deltoid or ovate bases. It is very homogeneous

[1] M. F. Koch. Studies in the anatomy and morphology of the Composite flower II. The corollas of the Heliantheae and Mutisieae. Amer. Journ. Bot. 17 : 1001–1002. 1930.

throughout the genus, the only variations occurring in the relative length and shape of the terminal appendage, but there is not sufficient noticeable variation in this character to apply it to practical use as a taxonomic criterion.

GYNOECIUM

The elongated arms of the style are quite different in the ray and disk florets. In the ray florets the style has two erect or ascending, slender branches, the papillate stigmatic lines following along the margins. The branches are glabrous or practically so on the inner and outer faces. In the disk florets the style also bears two erect to slightly spreading, straight branches, but each branch terminates in an ovate-oblong to narrowly linear-lanceolate, acute or obtuse appendage which is sparsely to densely hispidulous- or hirsutulous-pubescent on the external dorsal surface and along the margins, and glabrous on the internal ventral surface. The papillate stigmatic lines extend along the margins of the stylar branches to the base of the terminal appendage. The shape of the terminal appendage has proved to be of some limited use as a taxonomic criterion. Some species, *G. camporum*, *G. procera*, and *G. nana*, possess a relatively elongated, narrowly linear-lanceolate, acute or acuminate terminal appendage, in contrast to others, such as *G. rubricaulis* var. *robusta*, *G. squarrosa*, *G. maritima*, *G. texana*, *G. glutinosa*, *G. scabra* var. *neomexicana*, and many other species have relatively shorter and broader, oblong or oblong-lanceolate, obtuse to acute terminal appendages. In some species the terminal appendage is much more densely hirsutulous-pubescent on the outer dorsal surface than in others.

PAPPUS

In many ways the pappus characters permit of ready aid in the differentiations of species. The pappus in *Grindelia* is always strongly caducous, and this property distinctly separates it from all genera in the Astereae.

The pappus of a single floret consists of comparatively few awns or bristles, usually 2–10. According to Cabrera,[1] *G. buphthalmoides* may have as many as 15 or even more bristles. A number of South American species have 6–10 bristles to the florets, whereas the Mexican species possess mostly 2–3, sometimes 4 on the ray and outer disk florets. Some of the North American species, such as *G. texana*,

[1] A. Cabrera. Revisión de las especies sudamericanas del género "*Grindelia*." Rev. Mus. La Plata 33 : 224. 1931.

G. microcephala var. *adenodonta*, *G. lanceolata*, *G. nana* and *G. camporum* have only two bristles to the floret (*G. camporum* sometimes has three), whereas others, *G. subalpina* and var. *erecta*, usually have 4–8. *Grindelia rubricaulis* var. *latifolia* of the Santa Barbara Islands and the adjacent California coast may have as many as nine to the floret. When two bristles are present, they are found at opposite angles. When 5–9 or more are present, they are borne at and between the angles of the achene. Often two or more are found about each angle.

The number of bristles to the floret, though often variable, constitutes an important taxonomic character, since each species is characterized by a certain definite number of bristles to the floret. Great care is required, however, in determining this accurately. The number of bristles per floret may be the same throughout the head in some cases, whereas in many other instances the number on the ray floret will exceed that on the disk floret. It is often possible to find florets which have all the bristles in place, and to obtain a certain count, but the bristles are so easily caducous that their numerical determination is a very difficult problem. At the mere touch of a dissection needle the bristles in a head which is in anthesis readily disengage themselves from the achene. Furthermore, the florets in a head are closely packed together and they as well as the bristles are covered with resinous secretion; consequently, when one attempts in a dissection to separate one floret from another or a group of florets from another group, the bristles become easily separated from the achene and fall off or become transferred by their sticky surfaces to another floret. The author has often spent tedious hours making dissections of many heads of a plant in his attempt to be certain of the number of pappus bristles in one floret.

The best method found by which one may obtain more or less certain numerical determinations of the number of bristles to a floret in herbarium is to boil very young heads or those which, at least, have not reached anthesis, and then make the dissections of this material. In the young heads and in those which have not reached anthesis the connection between the achene and the bristle is still weakly intact.

Another method which is sometimes the only other alternative and which with careful dissection often yields more or less certain results is that of counting the total number of bristles in a head as well as the total number of florets and dividing the former by the latter. This latter is sometimes the only method available where

all the heads are in a mature condition. It is the very caducous nature of the pappus which has caused previous inaccuracies concerning the number of pappus bristles.

The relative length of the pappus bristle compared with that of the entire corolla of the disk floret is another character of taxonomic significance. In some species, *G. texana*, *G. lanceolata*, *G. scabra* var. *neomexicana*, *G. inuloides* var. *adenodonta*, *G. littoralis*, and *G. camporum*, the bristle is as long or nearly as long as the length of the corolla of the disk floret, whereas in *G. integrifolia*, *G. integrifolia* var. *virgata*, *G. rubricaulis* var. *elata*, and a few others it is only one-half to two-thirds the length of the corolla of the disk floret.

The relative width and thickness of the pappus bristle is a character of importance. In all Mexican species, in *G. microcephala* and varieties, and in *G. scabra* and var. *neomexicana*, the bristles are very delicate and capillary-like or filiform in appearance. Although they are not terete as true hairs, nevertheless they have the delicate, filiform appearance of hair, and are of the same narrow breadth from base to apex. All the other species have subpaleaceous, paleaceous, or strongly paleaceous bristles. The subpaleaceous type occurs in *G. Havardii*, *G. arizonica*, *G. aphanactis*, and others. They represent transitions from the capillary-like or filiform examples of the Mexican species to the more truly paleaceous types. As such transitions they are on the border line and are sometimes difficult to place. However, close comparison of these transitional, subpaleaceous forms with the real capillary-like types reveals the finer distinctions between the two. The strongly paleaceous types of bristles are best developed in the maritime or coastal species, such as *G. maritima*, *G. Blakei*, *G. rubricaulis* var. *latifolia*, and *G. camporum*.

A very interesting characteristic shown as regards the bristles is the relative curvature or straightness exhibited in the dried condition of herbarium material. All the Mexican species, and those showing close relationship to the Mexican types, such as *G. scabra* and var. *neomexicana*, *G. microcephala* and varieties, *G. grandiflora*, *G. oolepis*, *G. Havardii*, *G. arizonica* and varieties, *G. aphanactis*, and *G. decumbens* var. *subincisa*, possess fairly straight bristles when they are dry. Others, including the large proportion of species of the United States and Canada, possess bristles which are slightly to strongly curved or twisted when dry. This is well shown in *G. nana* and varieties, *G. maritima*, *G. Blakei*, *G. rubricaulis* var. *robusta*, *G. arenicola*, and many others. Those species with strongly paleaceous bristles or those which grow in proximity to the sea invariably ex-

hibit strongly curved or twisted bristles when dry, whereas the types with delicate, capillary or filiform bristles invariably possess straight bristles in the dried state.

One of the most important diagnostic characters for the differentation of the species is the margin of the pappus. This is a taxonomic criterion which has either been entirely neglected by previous students or has been misused or erroneously treated. Several species, among them *G. texana, G. lanceolata, G. microcephala* and varieties, *G. nana* and varieties, *G. camporum* and varieties, *G. integrifolia, G. integrifolia* var. *virgata, G. Greenei, G. Greenmanii, G. tenella, G. Robinsonii, G. oxylepis, G. inuloides, G. inuloides* var. *glandulosa, G. oolepis, G. Nelsonii, G. Palmeri,* and *G. subdecurrens,* have the margins of the pappus bristles entire or subentire (only remotely marked with a few short projections). Many others possess all degrees of serrulations.

For the sake of clarity, the author desires to explain at this time the terms used in his monograph in describing the pappus margins. The use of the terms "entire" and "subentire" is obvious and requires no explanation. Three main types of dentation are found on the margin of the pappus bristles in *Grindelia:* namely, first, the serrulate type with relatively short or minute, deltoid, broadly or ovate-lanceolate teeth, i.e. those about as long as broad or only 2 or 3 times longer than broad; second, the setulose type with relatively elongated, linear or subulate teeth, i.e. those many times longer than broad; and, third, the setulose-serrulate type—an intermediate condition between the first and second in which there may be both types (serrulate and setulose teeth) present or the teeth themselves may be intermediate in length between the serrulate and the setulose type. Among the three types themselves all gradations are found. There are again three general categories under each of the previous types: namely, first, remotely, second, moderately, and third, numerously toothed. In the first the teeth are few and rather distant from one another; the second type is intermediate in its degree of serration as to the proximity and number of teeth; in the third the teeth are abundant and numerous and relatively very close together. Therefore, we may have either remotely, moderately, or numerously serrulate margins, or remotely, moderately, or numerously setulose-serrulate margins, or again, remotely, moderately or numerously setulose margins. In *G. subalpina* and var. *erecta, G. scabra* and var. *neomexicana,* and *G. glutinosa* the bristles are numerously setulose. Between these types and those with entire margins are all stages.

The bristles are opaque, cream-colored, or pale brown, smooth, with shining surfaces, and are composed of many small, oblong cells. They are mostly compressed-flattened in the upper half or throughout or may be triquetrous below or in the lower half. They usually taper gradually from base to apex to an acute or an acuminate tip, but in some species, *G. microcephala*, *G. microcephala* var. *adenodonta*, *G. texana*, and a few others, they are dilated or enlarged at the tip.

ACHENE

The achenes of *Grindelia* are usually narrowly or broadly oblong and two to several times longer than broad. They vary from relatively small, approximately 1.5–2 mm. long and 0.75–1.5 mm. broad, to relatively large, 5–7.5 mm. long and 2.5–3.5 mm. broad. In *G. microcephala* var. *adenodonta* they are depressed rhomboid or cuboid, therefore as broad as or sometimes broader than long. The achenes have a firm, glabrous, crustaceous or corky-thickened pericarp. They vary in color from stramineous or pale brown to dark brown, seal brown, or burnt sienna. The angles are often more thickened than the rest of the achene. The angles may be rounded or sharply acute, slightly winged, with a narrow, membranous portion, or not at all winged.

The achenes of the ray florets ordinarily differ in cross section from those of the disk florets. The latter usually being more compressed, at least on four sides, and being more crowded, are usually semi-flattened or compressed, therefore much broader than thick, appearing 2-sided only, and oblong, elliptic-oblong, or fusiform in cross section. In some species, *G. squarrosa*, *G. oxylepis*, *G. microcephala* var. *adenodonta*, *G. subdecurrens*, *G. inuloides*, *G. sublanuginosa*, and a few others, they are quadrangular or subquadrangular and rectangular or squarish in cross section. The ray achenes may be triquetrous, quadrangular, or subquadrangular, and are frequently much broader or have a greater diameter than those of the disk florets, particularly of the latter toward the center of the disk. The triquetrous ray achenes occur in the majority of species and are triangular or subtriangular in cross section, whereas the quadrangular or subquadrangular types which are squarish or rectangular in cross section are found mostly in many of the Mexican species, and some of those obviously closely related to or derived from the Mexican species, such as *G. microcephala*, and varieties, and *G. squarrosa*. In the triquetrous ray achenes the two inner faces are mostly straight, or sometimes slightly convex.

The surfaces of the achenes, particularly in the Mexican species, show diversities which are characteristic and definite for the different species, and thus serve as a very important diagnostic character in specific differentiation. In *G. nana* and varieties, *G. Havardii*, *G. lanceolata*, and *G. littoralis*, the surface of the faces is smooth and mostly free from surface irregularities. In *G. grandiflora* the achenes are conspicuously 9–10-costate or ribbed with slender, longitudinal ribs alternating with rather deep sulcations. In *G. aphanactis* the faces are as a rule deeply longitudinally ribbed and furrowed. In other species the achenes are irregularly or slightly ribbed only about the angles. Some of the maritime species, *G. humilis* and *G. Blakei*, have the faces grooved irregularly and longitudinally, or ribbed or thickened, the outer convex face in *G. humilis* often being irregularly roughened or thickened. Some of the Mexican species, *G. tenella*, *G. oxylepis*, *G. sublanuginosa*, and also the Texan *G. microcephala* var. *adenodonta*, have the faces finely or coarsely and irregularly rugose-wrinkled or convolutely rugose. In *G. oxylepis* this convolute rugosity is very fine, while in *G. sublanuginosa* and *G. microcephala* var. *adenodonta* it is much coarser and deeper.

Diversity in the type of apex about the areola of the achene at maturity offers differentiating specific characters of fundamental, deep-seated importance. Two main types are present, one in which the apex of the achene is horizontally or obliquely truncate, the other in which the areola is bordered at the angles with little, toothlike processes or knobs, or the angles and margins between the angles may develop a shallow or prominulous, irregularly undulate or thickened ridge or upraised rim. This rim may be more prominently developed at one of the angles and thus appear like a knob or toothlike process, or it may be developed at all the angles. The knobbed or toothlike angles at the apex are commonly encountered in many of the Pacific Coast species, such as *G. camporum* and varieties, *G. rubricaulis* var. *robusta*, *G. hirsutula* and varieties, *G. procera*, *G. maritima*, and *G. humilis*, and in some other species like *G. columbiana*. *Grindelia nana* and varieties have 1–3 very short projections or knobs, and *G. texana* and *G. lanceolata* of the south-central United States and Texas have 1–2 very short processes at the apex or only a shallow, upraised rim. All the Mexican species have horizontally truncate apices. *Grindelia squarrosa*, *G. arizonica* and varieties, *G. subalpina* and var. *erecta*, *G. microcephala* and varieties, *G. perennis*, *G. inornata*, and other interior land types have the apices of the achenes horizontally or obliquely truncate.

It should be emphasized, however, that as in *Carex* neither the surface markings on the achene, nor the shape and size, nor the type of apex can be used as critical characters unless the achenes of the specimens examined are fully mature. Otherwise confusion is likely to result. The achenes of *G. microcephala* var. *adenodonta*, for example, are smooth to slightly rugose in the early stages, but at maturity, and not until then, are conspicuously and convolutely rugose-wrinkled. In some of the Mexican species like *G. inuloides*, *G. subdecurrens*, *G. Robinsonii*, *G. Palmeri*, and *G. Greenmanii* the faces are mostly smooth in the beginning and do not show signs of shallow wrinkling or other rugosities until late maturity. Great care must be taken in using achenial characters in the key to species, varieties, and forms in the monograph.

A NEW GRINDELIA FROM MEXICO

Grindelia confusa Steyermark, sp. nov.—Herba perennis, caulibus tenuibus, pluribus, adscendentibus, monocephalis vel paucicephalis, dimidio superiore villosiusculis, 1.5–2 dm. altis; foliis per omnes partes plerumque aequalibus firmiter membranaceis, salienter vel spinulose dentatis, 1.5–3.3 cm. longis, 0.2–0.5 cm. latis, linearibus, acutis, minute glandulosis; capitulis radiatis, 2.5–3 cm. latis; disco campanulato-hemispherico, 0.7–0.8 cm. alto, 1.3–1.5 cm. lato; involucro parce resinoso, involucri bracteis apice patentibus vel paullo squarrosis, exterioribus et mediis 5–6 mm. longis, ca. 0.5 mm. latis, tenuibus, lineari-subulatis, glabris; ligulis 25–31, 8–9 mm. longis, ca. 2 mm. latis; achaenio immaturo laevi; aristis 3–5, tenuibus, modice setulosis, 3–4 mm. longis, ca. ⅞ longitudinem disci floris aequantibus.—Mexico: Chihuahua, swale, Namiquipa plains, *Harde LeSueur 1016*, August 17, 1936 (type in Herbarium of Field Museum).

Grindelia confusa from the Chihuahuan plains, with its spinulose-dentate, linear leaves and moderately setulose awns, differs from all the other Mexican species. It is most closely related to *Grindelia laciniata* of Arizona and southeastern Utah, differing chiefly in its involucral bracts, which are linear-subulate with free, spreading, slender tips, in its more spreading-ascending stems which are pubescent instead of glabrous, in its more setulose pappus awns, and in its leaf margins, which are spinulose-dentate rather than pinnatifid.

It is somewhat of a surprise and rather disconcerting to encounter such a distinct new species, not only because the author has already monographed the genus, but also because the characters of this new

species spoil some of the key characters based upon geographical distinctions and awn characters. It actually combines the habit, pubescence, and involucral bracts of some of the Mexican species with the leaves and pappus awns of some southwestern United States species.

As this paper goes to press, it is somewhat unusual to record another species of *Selenia*, *S. grandis* Martin, newly described from the same county in Texas as that from which *S. oinosepala* has been found. That the two species are totally distinct, however, is borne out by the much smaller and entirely different colored sepals of *S. oinosepala* and by the twice as large petals of *S. grandis*.

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